DoD High Level Architecture Overview

September 1998

Integrated Training Program

Defense Modeling & Simulation Office
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http://www.dmso.mil/

Evolution of DoD M&S Strategy

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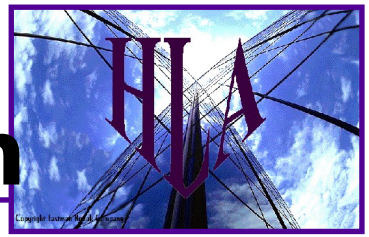
M&S Critical to DoD's Ability to Meet its Mission



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Continuing squeeze on DoD resources

- Shrinking, dispersed force structure
- Competition for O&M funds limits field exercis
- Need to carefully examine every investment

More demanding operational requirements

- New, more complex missions
- Vastly expanding mission spa
- Increased complexity of systems and plan
- Increasing demand for joint training
- Security challenges (e.g., information warfa
- No traditional way to address

Much more technical capability at less cost

- Communications
- Computers
- Advanced software technology
- Displays/human-machine interfaces
- Data storage and management

Advanced M&S offers a cost-effective and affordable solution

How Did We Get Here?

Technical progress spurs management response

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Technical

Limited scope simulations, little interoperability prior to 1988

SIMNET

DSB: Computer Applications to Training and Wargaming Study for CJCS

DARPA-SACEUR Distributed Wargaming System ACE-89

DIS Standards begun

ALSP: linking of Service wargames

New programs (JSIMS, JWARS)

High Level Architecture (HLA) begun

HLA policy established

88 89 90 91 92 93 94 95 96 97 98

DoD Simulation Policy Study

SECDEF Memo: EXCIMS formed and DMSO established

DoD Dir 5000.59 M&S Management

DoD 5000.59-P M&S Master Plan

DoD VV&A Instruction

All Services' M&S offices in place

DoD M&S Executive Agents

Architecture Management Group

SBA Task Force

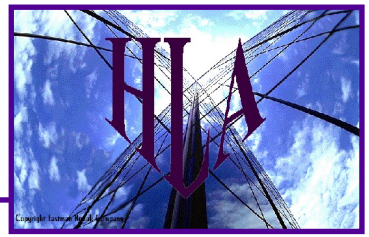
EXCIMS Functional Area Councils

HLA Transi Plan appro

Management

No formal management structure | Management structure stand-up | Management structure in place

OSD S&T Organization



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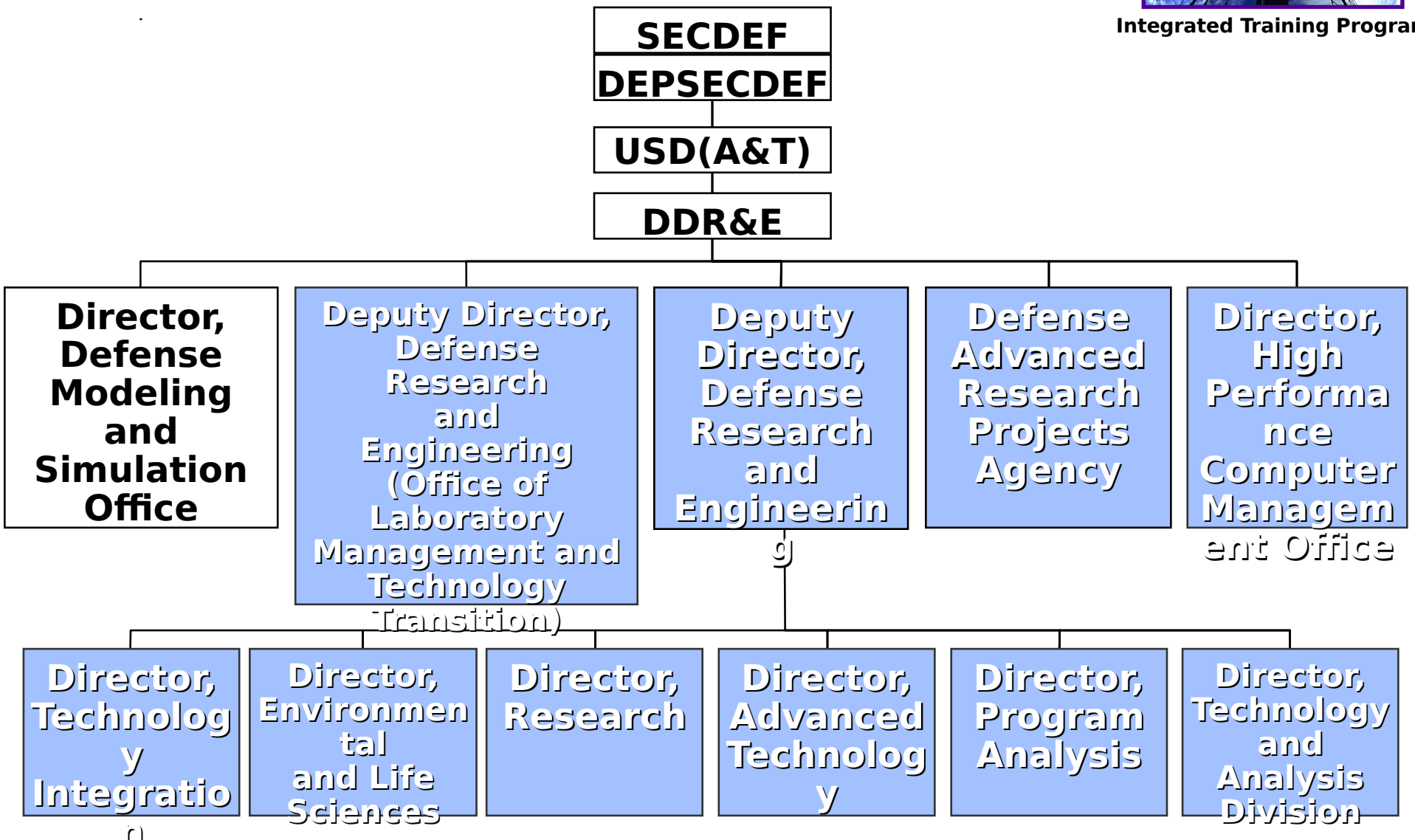
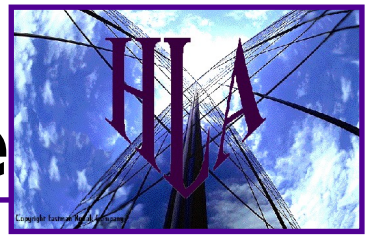

SECDEF
DEPSECDEF
USD(A&T)
DDR&E
Director, Defense Modeling and Simulation Office
Deputy Director, Defense Research and Engineering (Office of Laboratory Management and Technology Transition)
Deputy Director, Defense Research and Engineering
Defense Advanced Research Projects Agency
Director, High Performance Computer Management Office
Director, Technology Integration
Director, Environmental and Life Sciences
Director, Research
Director, Advanced Technology
Director, Program Analysis
Director, Technology and Analysis Division

DoD M&S Management Structure



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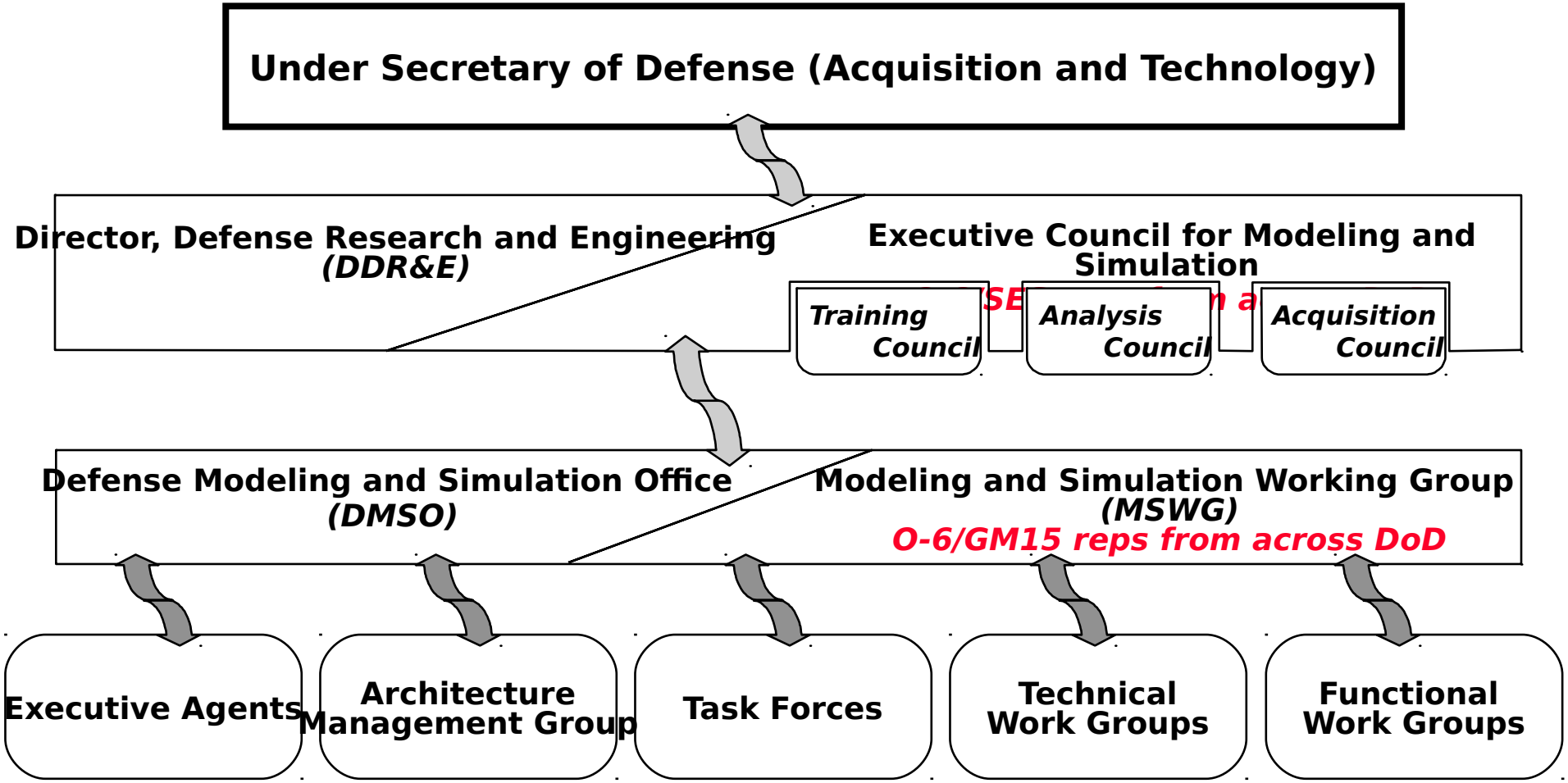
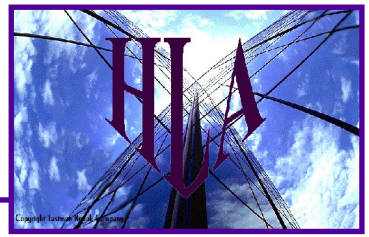


DoD M&S Vision



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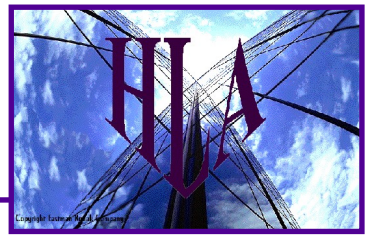
- **Defense modeling and simulation will provide readily-available, operationally-valid environments for use by DoD components**
  - **To train jointly, develop doctrine and tactics, Formulate operational plans, and assess war fighting situations**
  - **As well as to support technology assessment, system upgrade, prototype and full scale development, and force structuring**
- **Furthermore, common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow maximum utility and flexibility, these modeling and simulation environments will be**

DoD Executive Council on Modeling and Simulation (EXCIMS), March 13, 1992

DoD M&S Master Plan Objective 1-1



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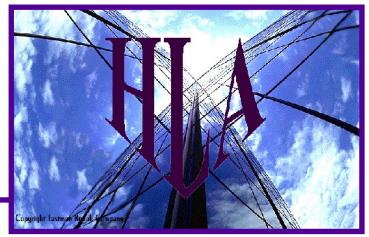
- **Objective 1-1**
- **Establish a common high-level simulation architecture to facilitate the interoperability of all types of models and simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components**
- **Simulations developed for particular DoD Components or Functional Areas must conform to the High Level Architecture**
  - **Further definition and detailed implementation of specific simulation system architectures remain the responsibility of the developing Component**

The Common Technical Framework, and specifically the High Level Architecture, represents the highest priority effort within the DoD modeling and simulation community

DoD HLA Policy



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- **DoD Policy:**

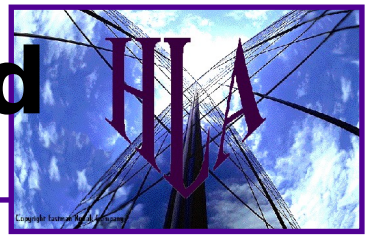
"Under the authority of [DoD Directive 5000.59], and as prescribed by [the DoD Modeling and Simulation Master Plan], I designate the High Level Architecture as the standard technical architecture for all DoD simulations."

- **HLA supersedes Distributed Interactive Simulation (DIS) and ALSP**

- **"No Can" Dates**
  - **"No Can Pay"- first day of FY99**
    - **No funds for developing/modifying non-HLA-compliant simulations**
  - **"No Can Play"- first day of FY01**
    - **Retirement of non-HLA-compliant simulations**

- **Waivers must be decided on a corporate basis**

DoD HLA Policy Reaffirmed



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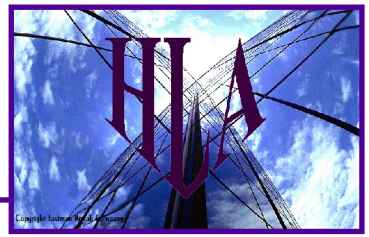
DoD Transition Policy

"We must foster broad simulation interoperability and reuse if the Department is to cost-effectively harness the potential of simulation to improve DoD operations."

"All new simulations will be built in accordance with the HLA.
To reap the full benefits of simulation interoperability and reuse
in the near-term, it is also important to quickly transition our legacy simulations to the HLA, … . I am firmly committed to this policy and will insist the Components plan and program accordingly. I encourage our industry partners to follow suit"

Dr. J.S. Gansler, USD(A&T)
7 April 1998

Why HLA Now?



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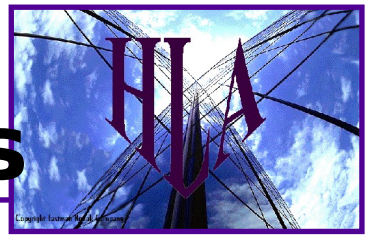
- **DoD M&S Vision**
  - **“ ...common use of these environments will promote a closer interaction between the operations and acquisition communities in carrying out their respective responsibilities. To allow maximum utility and flexibility, these modeling and simulation environments will be constructed from affordable, reusable components interoperating through an open systems architecture.”**
  - **DoD embarking on development of new generation of simulations**
- **Current technology does not provide tools necessary to achieve DoD M&S Vision (i.e., ALSP and DIS)**

How HLA Will Extend DIS and ALSP Capabilities



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HLA vs. DIS capabilities:

- HLA applies to multiple time management schemes
  - DIS applies to only real-time, platform level niche of M&S market
- HLA separates data from architecture-- evolves data as required by applications
  - DIS embeds data in architecture causing protocols to be inflexible and ineffective
- HLA selectively passes data among simulations
  - DIS uses full broadcast distribution approach
    - Does not scale from a network or processor viewpoint

HLA vs. ALSP capabilities:

- HLA applies to multiple time management schemes
  - ALSP applies to only discrete-event, logical-time niche of M&S market
- HLA new, more robust approach designed in from onset
  - ALSP designed to accommodate legacy simulations
- HLA supports broad DoD user community
  - ALSP evolution driven by Joint Training Confederation (JTC) needs

Basic Overview of the High Level Architecture

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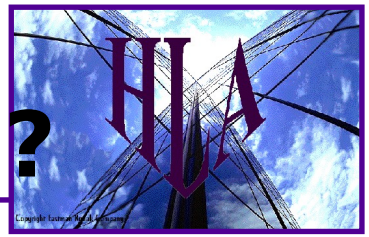
What is the High Level Architecture?



- The High Level Architecture is comprised of three elements:
  - Interface Specification
  - Object Model Template (OMT) Specification
  - HLA Rules for Federates and Federations
- These three elements commonly applicable across all DoD simulations, provide a common framework within which specific system architectures can be defined.

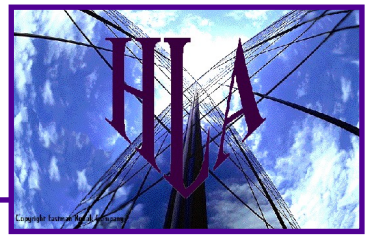
DoD Policy:

" Under the authority of [DoD Directive 5000.59], and as prescribed by [the DoD Modeling and Simulation Master Plan], I designate the High Level Architecture as the standard technical architecture for all DoD simulations."

Dr. Paul Kaminski
10 September 1996

10 September 1996

High Level Architecture (HLA) Development Process Overview



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DoD Policy Issued
10 Sept 1996

Checkpoints

Spec v1.1 2/97

Spec v1.2 8/97

Spec v1.3 2/98

Industry Solicitation

Previous DoD architecture efforts

Program Evaluation Team

Mar 95

Aug 96

Prototypes

Evolution

Initial definition of HLA

Baseline definition of HLA

IEEE Standardization Process begun 6/97

DoD Policy Reaffirme
7 April 1998

DoD-wide Architecture Management Group

16 members

22 members

Phase 1
Initial Definition

Phase 2
Baseline Development

Phase 3
Technical Transition

The High Level Architecture (HLA)

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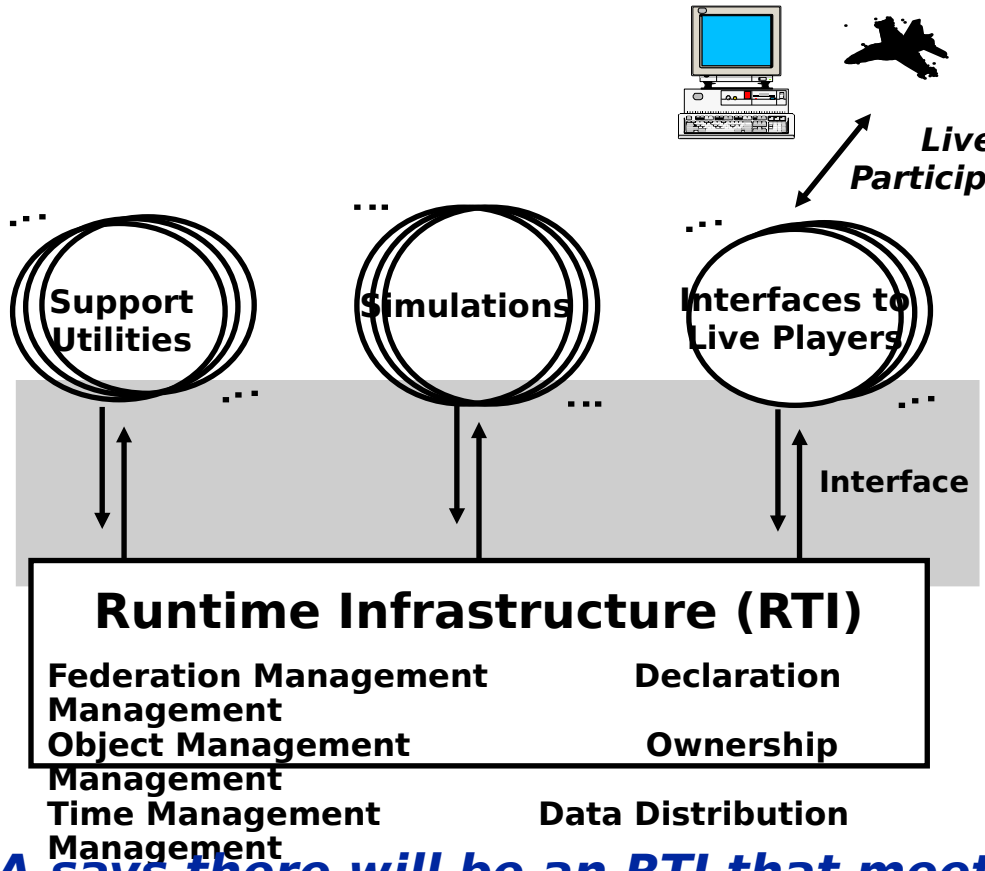
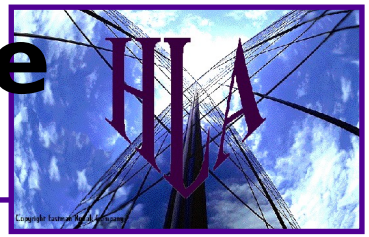
- Architecture calls for a federation of simulations
- Architecture specifies
  - Ten Rules which define relationships among federation components
  - An Object Model Template which specifies the form in which simulation elements are described
  - An Interface Specification which describes the way simulations interact during operation



The HLA is not the RTI; the HLA says there will be an RTI that meets A requirements but it doesn't specify a particular software implementat

HLA RTI Services over the Life of a Federation



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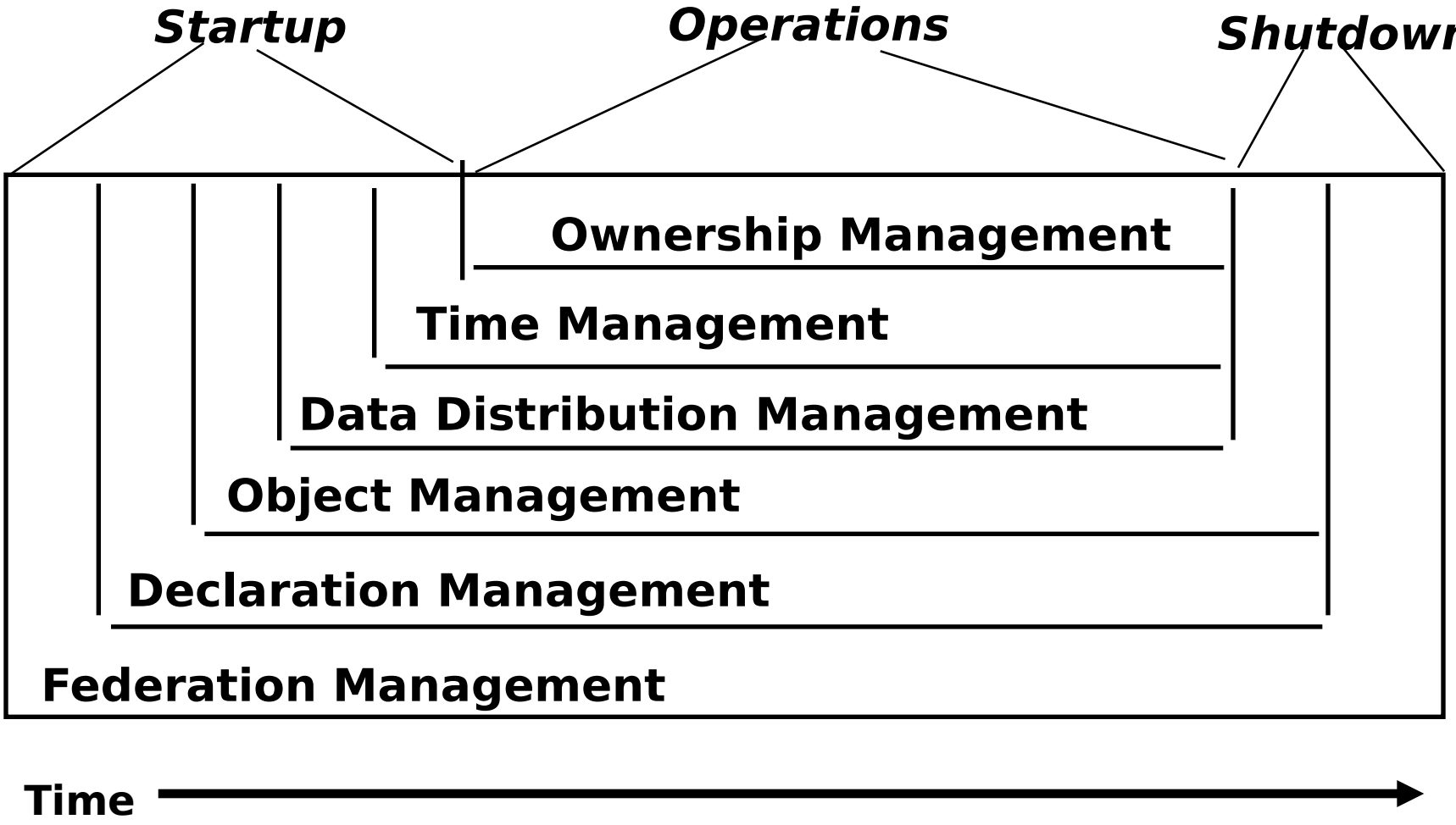
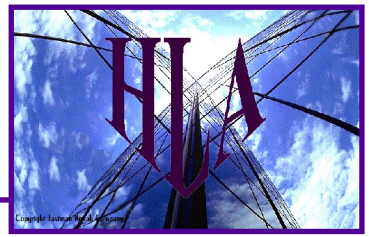


HLA Object Models and OMT



- **Federation Object Model (FOM)**
  - A description of all shared information (objects, attributes, and interactions) essential to a particular federation
- **Simulation Object Model (SOM)**
  - Describes objects, attributes and interactions in a particular simulation which *can* be used externally in a federation
- **Object Model Template (OMT)**
  - Provides a common framework for HLA object model documentation
  - Fosters interoperability and reuse of simulations via the specification of a common representational framework

Implementing the High Level Architecture

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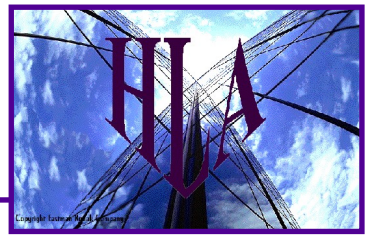
An Overarching Technical Framework



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DoD M&S Master Plan Technical Framework
(High Level Architecture, Conceptual Models of the Mission Space, Data Standardization)

Domain-specific aspects

Analytical Simulations (e.g., JAMIP, TACWAR)	Operational Level Training Simulations (e.g., JSIMS, WARSIM)	Tactical Level Training Simulations (e.g., CCTT, BFTT, aircraft simulators)	Training Ranges (e.g., JTCTS, Nellis, NTC)	Real Equipment (e.g., tanks, aircraft, C4I systems)	T&E Ranges (e.g., WSMR, ACETEF)	Engineering Level (RD, T&E) Simulations (e.g., JMASS, ESAMS)	Manufacturing Simulations (e.g., CATIA, CAD/CAM)	Other Simulations (e.g., human body sims)

Technology Development

Payoffs: Interoperability and reuse = capability and cost-effe

DoD M&S Strategy: An Analogy to City Planning

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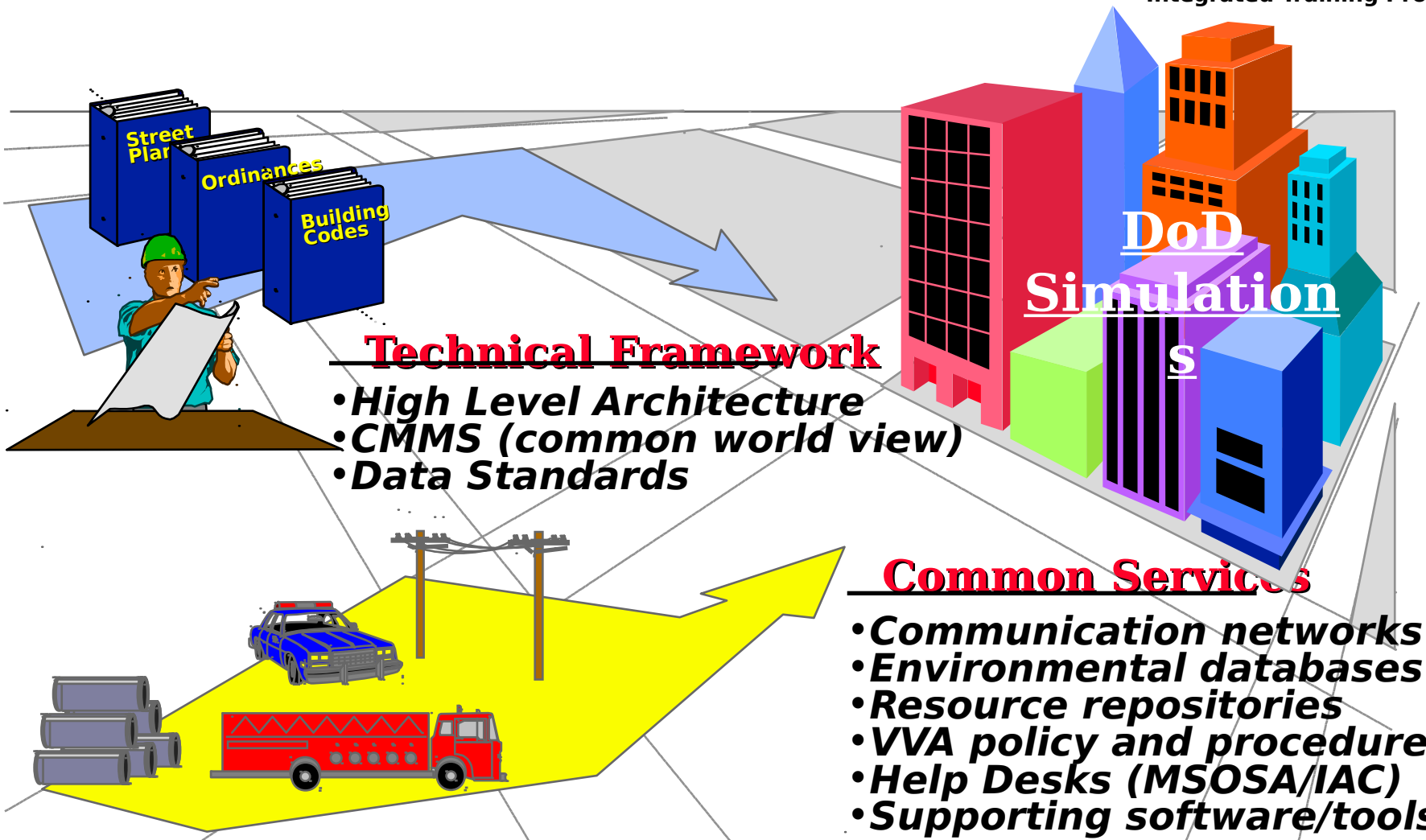


Technical Framework

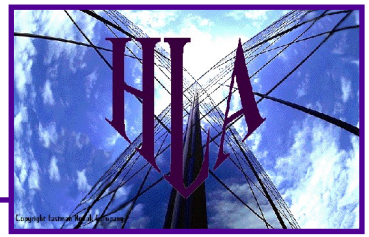
- *High Level Architecture*
- *CMMS (common world view)*
- *Data Standards*

Common Services

- *Communication networks*
- *Environmental databases*
- *Resource repositories*
- *VVA policy and procedures*
- *Help Desks (MSOSA/IAC)*
- *Supporting software/tools*

Payoffs: Interoperability and reuse = capability and cost-effectiv

HLA Evolving through an Integrated Product Team Structure



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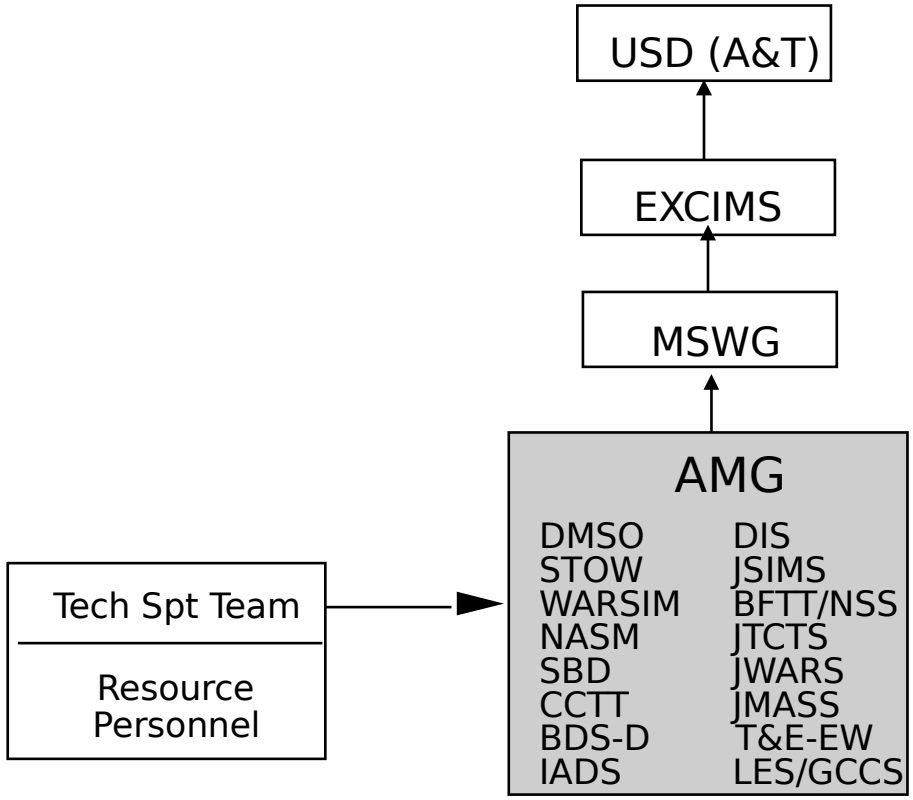


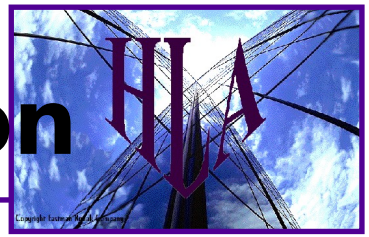
MSWG
Modeling and Simulation Working Group (0-6)

AMG
Architecture Management Group

Approximately 240 players total:

(Baseline)	35%	government
	12%	FFRDC
	5%	academia
	48%	industry

Premise for HLA Evolution



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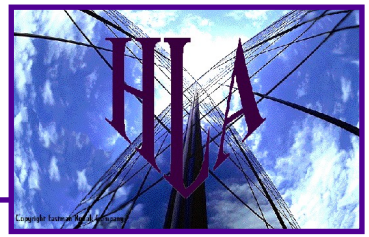
- Changes/enhancements should be based on issues raised by users of HLA
- Changes need to be evaluated in terms of benefits and impacts on the HLA user community
- AMG is the focus for evolution including identifying issues, evaluating options for addressing the issues, and approving changes
- As other programs begin implementation of HLA, they will be represented in the AMG process

Five Step HLA Evolution Process



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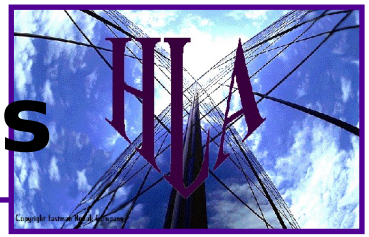
- **Step 1**
  - An AMG member expresses a need for a capability, options for meeting that need, and generality of need areas
- **Step 2**
  - A summary issue paper and investigation plan is developed, and issue team is formed to conduct investigation
- **Step 3**
  - Plan is executed, tech exchanges are conducted to review technological progress and issues, with status updates given at AMG meetings
- **Step 4**
  - Recommended changes to HLA spec are drafted, integrated across specifications, and reviewed by AMG technical community
- **Step 5**

Regular HLA Checkpoints



- Six month cycles will serve as routine checkpoints in the HLA process
- At least one month prior to each checkpoint
  - Progress of issue investigations will be checked
  - Proposed changes in architecture and impact on specification will be evaluated
  - Draft changes in specifications will be prepared for AMG review
- Changes are drafted and integrated across the specifications
- Checkpoints also provide timing for externally motivated changes in specifications (e.g. text updates, deleting parameters)
  - Specs have comment forms; these will be maintained by DMSO and coordinated via the TST

First Checkpoint was February 1997

HLA Supporting Software and User Services

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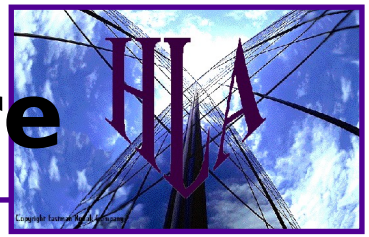
HLA Supporting Software



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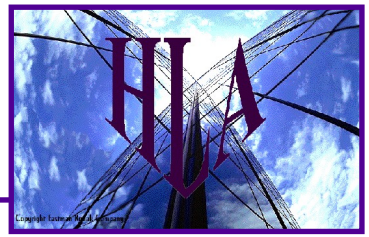
- **HLA is an architecture, not software -- however, to facilitate cost-effective implementation of HLA, DMSO is developing an initial suite of HLA support processes and supporting software**
  - **Federation development process model (FEDEP)**
  - **Runtime infrastructure software**
  - **Object model development and reference tools**
  - **Federation execution planning and verification tools**
  - **Federation execution runtime tools**
- **DMSO facilitates open distribution of supporting tools in the public domain**
  - **Open access to specifications (e.g., Object Model Template data interchange format) to foster development of commercial software to support HLA**
  - **Several DoD agencies have ongoing SBIR initiatives to develop HLA support tools**
- **Information source: HLA On-line (subscribe at http://www.dmso.mil)**

HLA Supporting Software: Runtime Infrastructure (RTI) Software



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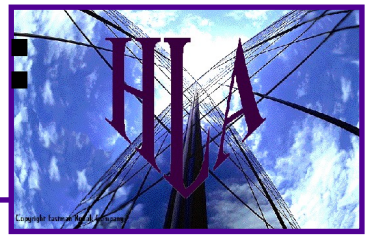
- RTI software is available now and can be ordered from DMSO homepage (http://hla.dmso.mil) under topic “HLA Software Distribution Center”
- Each user defines own account name and password
  - user account approved following one-time submission of registration data
  - registered users may access and download any products not previously downloaded
  - once registered you will be automatically notified of new releases
- RTI version 1.0 and version 1.3 are out now
  - platforms supported in DMSO-sponsored development reflect broadest requirement among current user population; follow-on development among commercial markets to address added demand
- RTI version 2.0 commercial development (under DMSO procurement) is underway; delivery expected Dec 1998

HLA Supporting Software:
Object Model Support Tools



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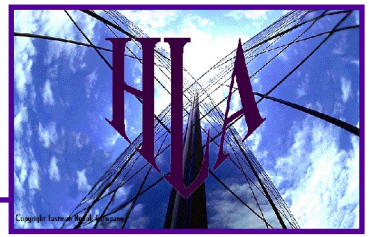
- **Object Model Development Tools (OMDTs)**
  - Automated support for development HLA Object Models (OMs), generation of RTI federation execution data, and exchanging OMs with the Object Model Library
  - Object Model Library (OML)
  - Web-accessible library for storing and retrieving completed HLA object models (SOMs and FOMs)
- **Object Model Data Dictionary (OMDD)**
  - An automated catalog of data elements for use in HLA object models
- **Initial public release of OM tools began October 1997**
  - Versions compliant with HLA Specification 1.3 released in March 1998
  - Currently one OMDT and access to OML available, same as RTI
    - OMDT ported to Windows NT/95, SGI IRIX 6.2, and Sun

New Tool Development Strategy



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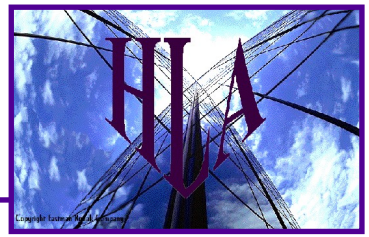
- **Development of additional tools has been initiated**
  - **Continuation of same basic strategy**
    - **DMSO develops initial releases, supported by open data standards to promote commercial developments**
    - **Development and testing will be done with alpha testing groups**
    - **Based on these results tools assessed to be generally useful and supportable will be generally released**
    - **Presentation on tools included in AMG agendas as tool work progresses**

HLA User Services



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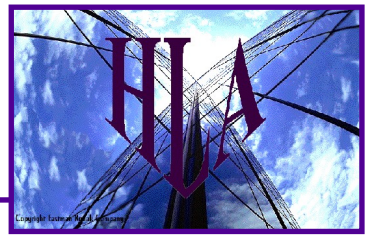
- **DMSO is fostering a broad range of User Services to facilitate the HLA transition**
  - **DMSO HLA Home Page**
  - **HLA Help Desk**
  - **HLA Technical Library**
  - **HLA Education/Outreach**
  - **HLA Compliance Testing**

HLA User Services:
DMSO HLA Home Page



Integrated Training Progra

- **Provides full service access to the broad HLA user community**
  - **materials, software distribution, training registration**

Netscape - [HLA HOME PAGE]
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Netsite: http://hla.dmso.mil/
TOPICS:
HLA Home Page
General Information
HLA Policy and Compliance Testing
HLA Technical Specifications
Runtime Infrastructure (RTI)
Federation Development Processes and Tools
HLA Software Distribution Center
Data Support for the HLA
HLA Implementations
Architectural Management Group (AMG)
HLA Education and Training
HLA Related Standards
Published Papers
Submit questions about HLA
What's New? Upcoming Events
Submit comments about HLA Specifications
HLA FAQ
DoD High Level Architecture (HLA)
In accordance with the DoD Modeling and Simulation Master Plan (DoD 5000.59-P, dated October 1995), the Defense Modeling and Simulation Office (DMSO) is leading a DoD-wide effort to establish a common technical framework to facilitate the interoperability of all types of models and simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components. This Common Technical Framework includes the High Level Architecture (HLA), which represents the highest priority effort within the DoD modeling and simulation community. Initial definition of the M&S High Level Architecture was accomplished under the sponsorship of the Defense Advanced Research Projects Agency (DARPA) Advanced Distributed Simulation (ADS) program. It was transitioned to the DMSO in March 1995 for further development by the DoD-wide Architecture Management Group (AMG). Central to this task was the development of a set of prototypes which addressed critical issues in the HLA. The HLA Baseline Definition was completed on 21 August 1996. It was approved by the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) as the standard technical architecture for all DoD simulations on 10 September 1996.
For rapid access to the most current briefings, papers and other information, check out
Document: Done
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STRS - Emp# 3...
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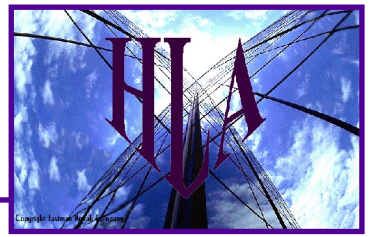
http://hla.dmso.mil

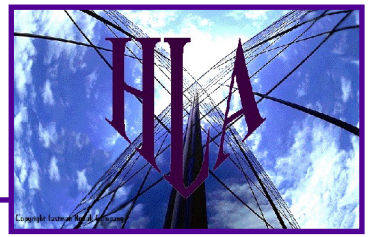
HLA User Services:
HLA Help Desk



Integrated Training Progra

- An online **Help Desk** was established in May 97
- Focal point for inquiries to DMSO on HLA
- **hla@msis.dmso.mil** e-mail goes to the HLA Help Desk
  - Directly responds to general inquiries
  - Refers
    - Training requests
    - Policy questions
    - RTI-specific technical questions
  - Logs and tracks
- Increasing level of activity

HLA User Services:
HLA Technical Library

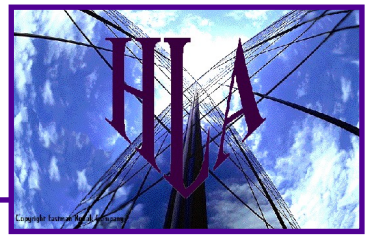


Integrated Training Progra

- **Integrated DMSO HLA training/outreach program is underway**
  - **primary focus has been on domestic US requirement, but some European training is being conducted (TNO, ESA, ITEC)**
  - **no cost to recipients other than TDY costs**
- **CONOPS evolves with user needs**
  - **First phase followed a “request-response approach”; shifting to providing regular training events**
  - **Continuing to add modules and update materials as the HLA program progresses**
  - **Partner with external organizations for education (MORS, OMG, SCS, SIW, ITEA)**

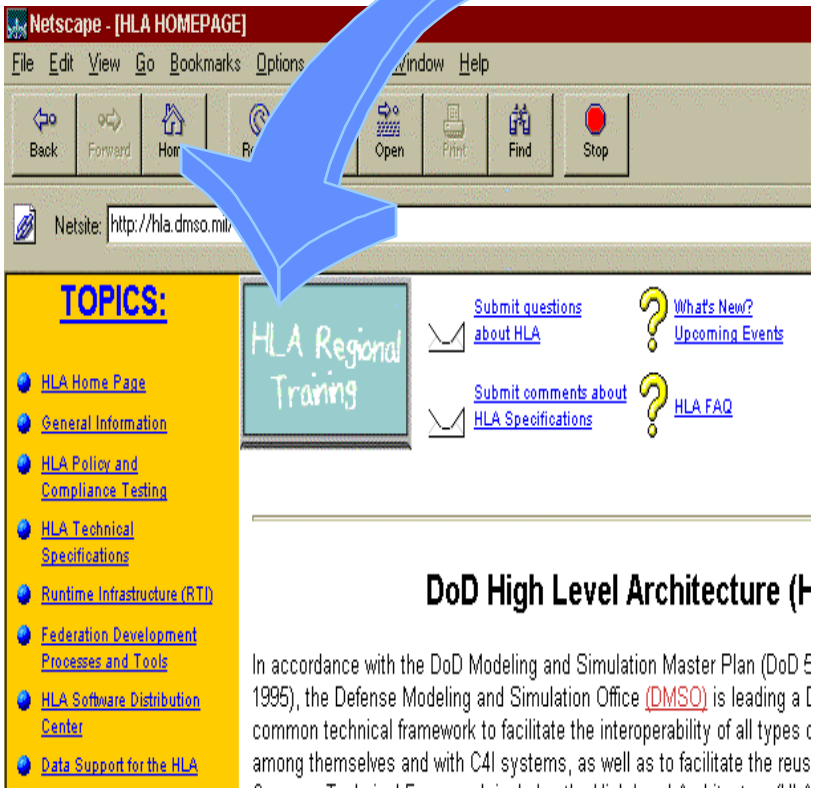
http://hla.dmso.mil

HLA User Services:
HLA Education/Outreach



Integrated Training Progra

- **Sign-up through HLA home page http://hla.dmso.mil**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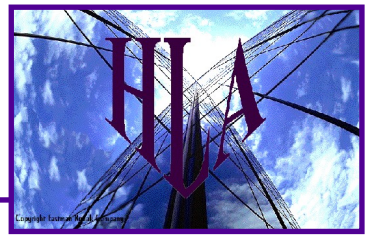
- **Regional -- Comprehensive introduction to HLA offered monthly**
- **Focused Training -- Half day focused sessions as adjuncts to Regionals or standalone offerings**
  - **HLA Compliance Testing**
  - **Adapting Your Simulation to HLA**
  - **Federation Development and Execution**
  - **Using Automated Tools to Develop HLA Object Models**
- **Hands-on Practicum -- twice a month offerings for implementer-level training in use of HLA**
- **CD education materials to supplement HLA live training**

HLA User Services:
HLA Federate Compliance Testing



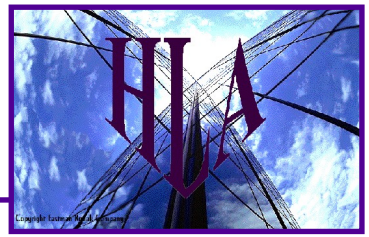
Integrated Training Progra

- **Compliance to HLA defined in 'HLA Compliance Checklist' and test procedures were developed with baseline definition**
- **Federate compliance testing**
  - **Straightforward, over the network**
  - **Minimal effort required by federate**
  - **A semi-automated Test Management System**
    - **Documented test process in easy-to-use guide: procedures, sizes, submission formats, examples, etc.**
    - **Web-based, on-line test preparation (for federates) and test management (for certification authority), integrated with test tools**
    - **Testing capability placed in operation 31 Oct 97**
- **RTI compliance testing**
  - **Testing system in development**

HLA and External Standards

Integrated Training Program

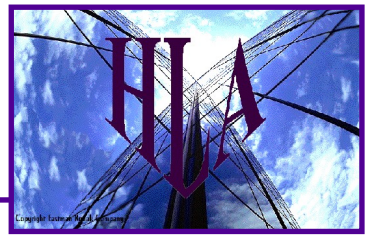
HLA in Related Standards Efforts



Integrated Training Progra

- **HLA is being promulgated as part of broader standards:**
  - **DoD Joint Technical Architecture (JTA)**
  - **North Atlantic Treaty Organization (NATO)**
  - **Simulation Interoperability Standards Organization (SISO) - for IEEE standardization**
  - **Object Management Group (OMG)**

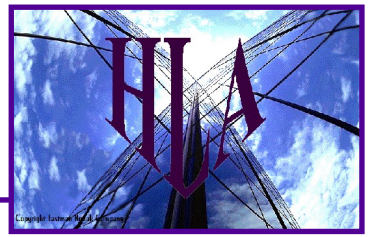
JTA 2.0



Integrated Training Progra

- **Restructured to provide for inclusion in the future of other kinds of standards beyond information technology: electrical, mechanical, etc.**
- **Begins expansion beyond C4I domain. A series of expansions is to establish a set of "open system building codes" for weapon systems and other areas.**
- **Adds annexes for three subject areas not included in JTA Version 1.0**
  - **Airborne Reconnaissance**
  - **Automatic Test Equipment**
  - **Modeling and Simulation, including HLA**
- **JTA 2.0 has been approved, currently awaiting release**

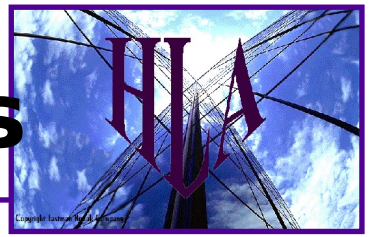
NATO Steering Group on M&S Objectives



Integrated Training Progra

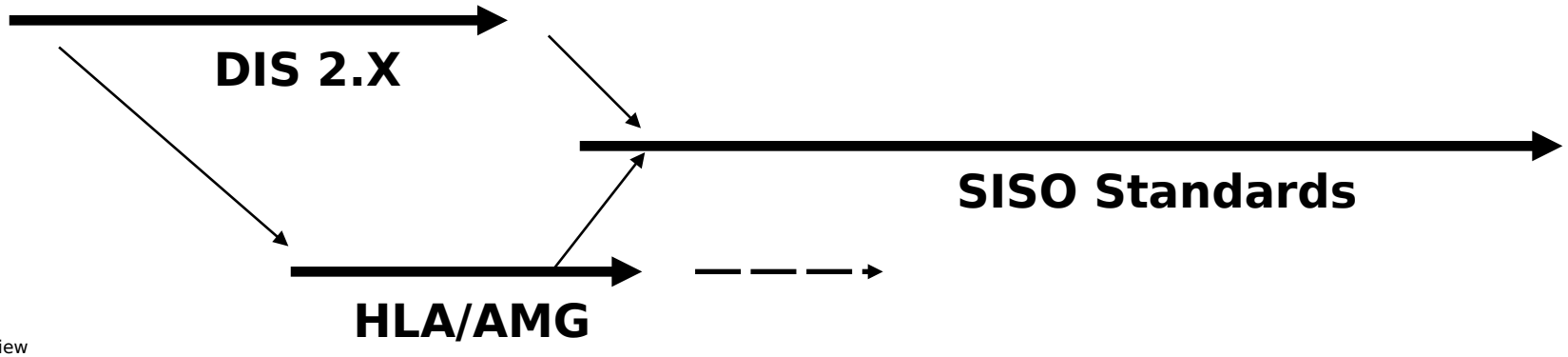
- **Formed in November 1996 to craft an Alliance approach to achieve simulation interoperability and reuse**
- **Major Activities**
  - **Develop a preliminary NATO M&S Master Plan, using the U. S. approach as a baseline and conducting "excursion analyses" to accommodate the NATO environment**
  - **Draft a roadmap to achieve prioritized NATO simulated environments**
  - **Recommend NATO policies regarding M&S management**
  - **Present a final report with the above products by Fall 1998**
- **13 nations active; detailed Programme of Work set**
- **HLA Technical Workshop in the Hague, 8-10 July 1997**
  - **Over 90 national simulation experts in attendance**
  - **DMSO provided HLA technical experts**
  - **Demonstrated HLA implementations**
- **Consensus emerging the HLA is the right technical architecture to support interoperability and reuse**

HLA Supporting Standards

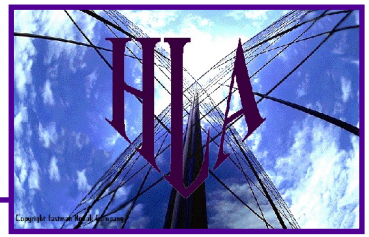


Integrated Training Progra

- **Important that HLA be integrated into broader, industry based technical community**
  - **Many HLA concepts/goals were birthed within DIS/IEEE workshop**
  - **HLA development supports achievement of the DIS Vision**
  - **DIS players are deeply involved in HLA development**
  - **The Simulation Interoperability and Standards Organization (SISO) (successor to the DIS Workshop) is the desired venue for establishment of HLA supporting standards**
  - **HLA has been nominated as an IEEE standard**



SISO/IEEE Standards



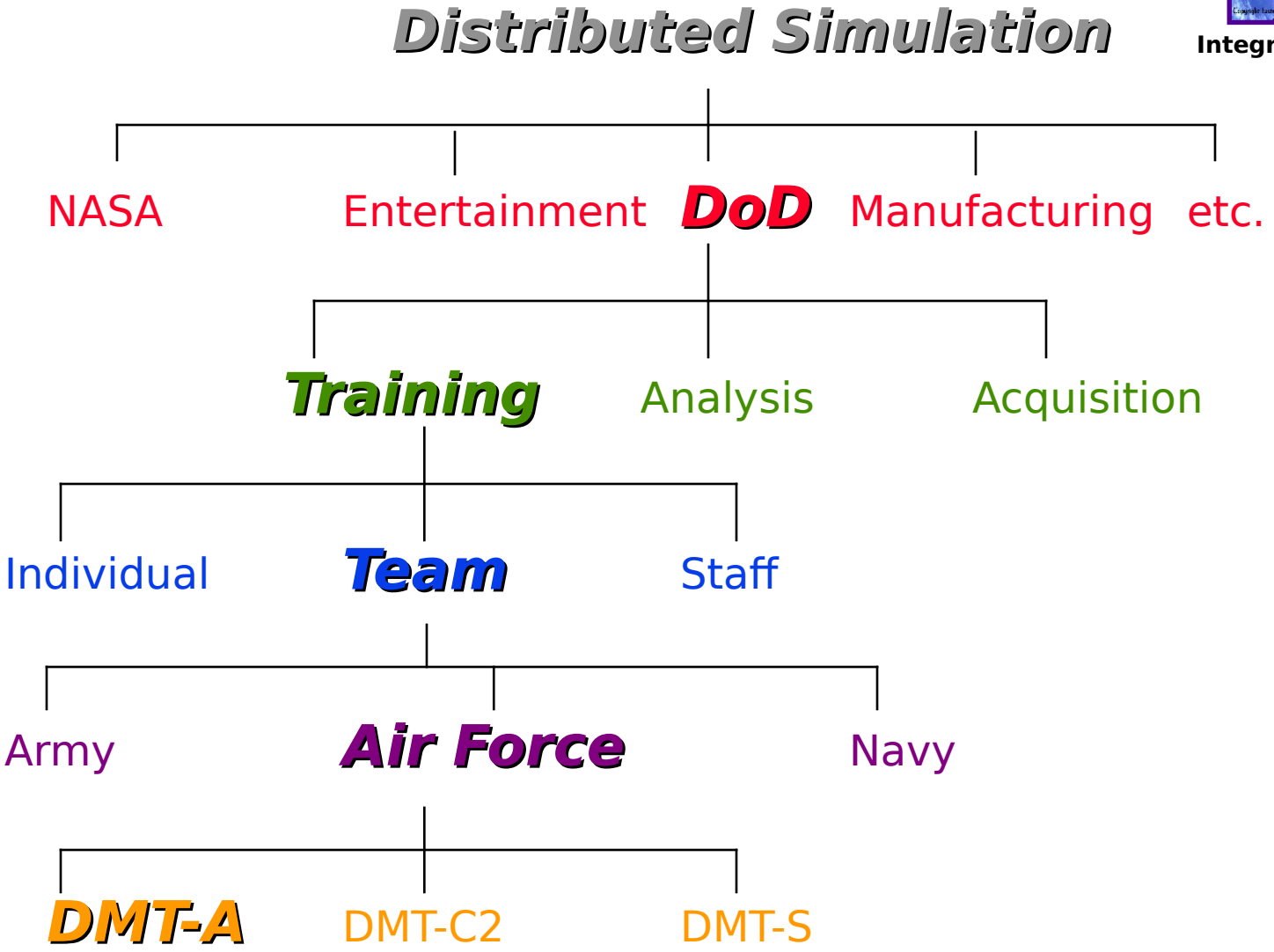
Integrated Training Progra

- In May 97, an HLA standards nomination was submitted by DMSO to the SISO Standards Activity Committee for IEEE standardization
- Standards Activity Committee (SAC) process is underway
  - Initial review successfully completed
  - SISO Executive Committee approved the standard nomination in September 97
  - The responsible Standards Development Groups have been formed and are in the process of creating the drafts for submission to IEEE
  - DMSO and AMG members are actively supporting the SAC process
- Expect three IEEE 1516 standards (HLA Rules IEEE 1516.1, I/F Spec IEEE 1516.2, OMT IEEE 1516.3) in fall/winter 1999

Standards and DMT

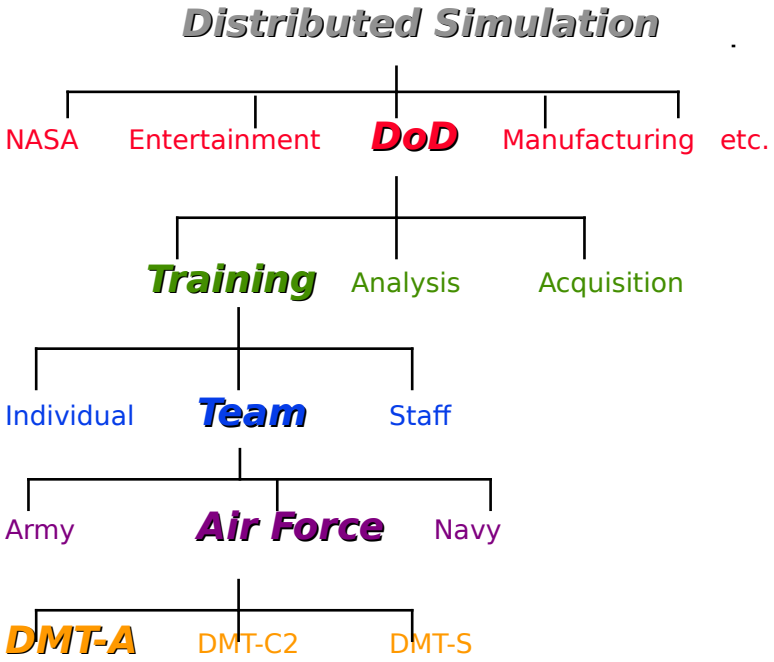
DMT Domain Slice

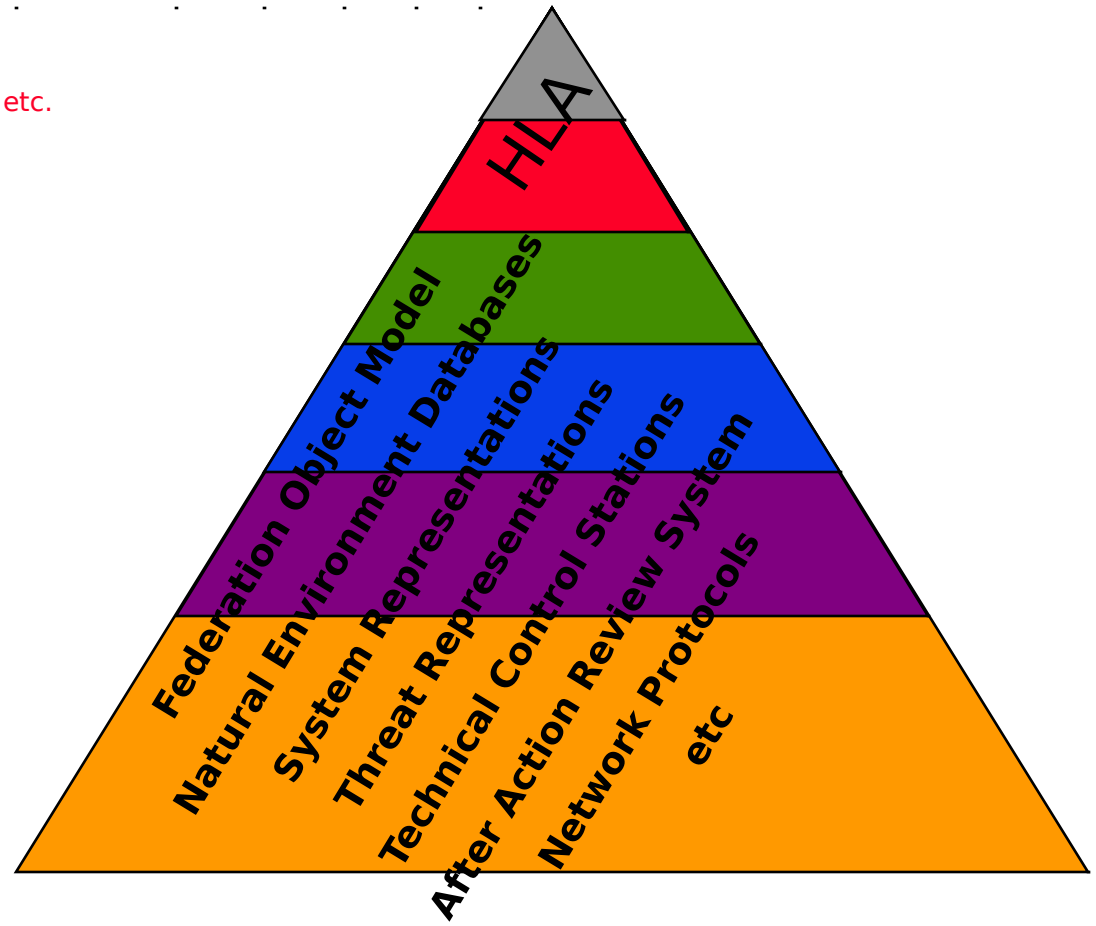
Integrated Training Progra



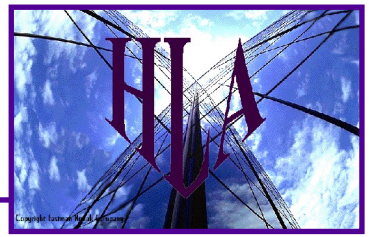
Standards for the DMT Domain Slice

Integrated Training Progra





HLA Myths



Integrated Training Progra

- HLA is constantly changing
- HLA cannot be changed to meet my requirements
- HLA manipulates data
- HLA does not work for real time systems
- HLA does not work for interfaces between simulations and C4I systems
- RTI is a central process and therefore a bottleneck
- RPR FOM should be the standard FOM for all applications
- RPR FOM should not be used at all - even as a reference